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Nenonen, Suvi; Eriksson, Robert ; Niemi, Olli; Junghans, Antje; Nielsen, Susanne Balslev; Lindahl, Göran

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Suvi Nenonen,
University Tampere University of Technology, Finland
suvi.nenonen@tut.fi
Robert Eriksson,
Aalto University, Finland
robert.eriksson@hel.fi
Olli Niemi,
Tampere University of Technology, Finland
olli.niemi@tut.fi
Antje Junghans
NTNU, Norway
Antje.junghans@ntnu.no
Susanne Balslev Nielsen
Technical University of Denmark, Denmark
SBNi@dtu.dk
Göran Lindahl
Chalmers University of Technology, Sweden
goran.lindahl@chalmers.se

Abstract

The future learning environments are not based on standardized design solutions like lecture theatres for 100 persons or classrooms for 40 persons. As new technology and new ways of studying are being developed new demands are put on university environments. At the same time utilisation of resources in form of both teachers and university facilities is challenged by development of integration of learning, teaching and the spaces where it takes place. The challenges are shared among users and owners of campus, where retrofitting is needed too. This paper aims to describe Campus Retrofitting (CARE)- methodology for user-centric and co-creative campus retrofitting processes. The campus development research in Nordic countries and co-creation in retrofitting processes are discussed. The campus retrofitting cases in different countries are described by emphasising especially the methods they used. Based on the analysis of the methods the framework for Campus retrofitting (CARE) - methodology is presented and discussed. CARE-methodology is a tool to capture new logic to learning environment design. It has three key activities: co-creating, co-financing and co-evaluating. The integrated methodology and the formulation of the guiding principle of the CARE-way of sustainable retrofitting of university campuses opens up an agenda for investigating a new methodology for sustainable urban retrofitting in a Nordic context.

Keywords: universities, space management, facilities management, space design

1. Introduction

The Nordic countries have much in common, historically, culturally and linguistically. They have had a common labour market and strong co-operation in many areas for many years. The Nordic welfare state model is based on the rights of individuals to a decent life and equal opportunities for social promotion, often achieved through education. Higher education is a part of their large public sectors and has been influenced by a powerful nation-state in which regional policy considerations and the social thesis of equal educational opportunity have played an important role (Fägerlind et al. 2004). Nordic countries have a strong research and development drive in campus development. The challenge is to apply the research results to campus retrofitting practices: how and what kind learning environments to develop. Nearv et al. (2010) claim that the intelligent estates director, from a position of blindly reacting to academic demands and maintaining the existing stock, has taken a pro-active role in contributing to the academic and business planning process by presenting options, identifying under-utilised resources, and mapping out pathways to achieving academic aspirations. Also Nielsen et al (2012) emphasise the significance of interactive co-creation between an actor and stakeholders surrounding the actor as a way to develop future learning environments and in particular for sustainable retrofitting of universities.

The future learning environments are not based on standardized solutions. Universities are under pressure to expand, change and find greater efficiencies. They have recognised the value of their estate both as a real estate asset and vehicle to open up opportunities for innovative teaching. All Nordic university property management organisations emphasise, that their operations need to be sustainable from economic, environmental and social perspective. There is a need to preserve the cultural heritage, since the university properties are often culturally valuable and reflect the society in general (Anon. 2010).

This paper aims to describe Campus Retrofitting (CARE)- methodology for user-centric and co-creative campus retrofitting processes. First the campus development research in Nordic countries and co-creation in retrofitting processes are discussed. Then the campus retrofitting cases in different countries are described by emphasising especially the methods they used. Based on the analysis the framework for Campus retrofitting (CARE) - methodology is presented and discussed.

2. Campus Retrofitting

2.1 Need to Retrofit Learning Environments

A university's campus is seen as a huge learning environment, which creates possibilities for learning – also across the university's academic environments (Anon. 2013). The last thirty years have witnessed dramatic developments in higher education. In Danish literature it is stated that an important parameter in world-class universities is a vibrant and challenging physical research and study environment. Physical planning is of great significance to the quality of the study and research environment at and around universities. (Anon. 2009) New methods of

learning, new creative work environments, internationalisation, digital possibilities, and not least urban development and more stringent energy requirements continually increase the demands concerning the physical setting (Anon. 2013). In Norway thirty projects, which address such issues as the future of the prototypical greenfield campus were collected in order to understand how inner city campuses are transforming the urban context and include prominent corporate enclaves and their ideological underpinnings (Hoeger and Christiaanse 2007).

In Sweden Karolinska Institute and Stockholm County Council (SLL) had a research and development project about Future Learning Environments in 2010-2012: How Space Impacts on Learning. They used the concept of the learning landscape to explore the range of learning environments needed at multiple scales to better align with changes in the medical education curriculum. Four key scales that correspond to important types of learning spaces are identified: the classroom, the building, the campus and the city. “In- between” spaces were identified as growing in importance given changing patterns of learning and the use of information technology. The focus from singular spaces to networks of inter-connected virtual and digital environments was considered as a critical shift. The need for higher levels of engagement of faculty, administrators and students in defining the briefs for the design of new kinds of medical education environments was highlighted (Nordquist and Laing 2015). By using more sociological perspective (Leijon 2012) states, that space shapes interaction, but interaction also shapes space; thus, it is essential to consider space in relation to negotiation and transformation (Leijon 2012). According to Nenonen and Lindahl (2014) inter professional interactivity and boarder zones between the traditional hierarchy, space segments and organisational structures as learning environment need to be identified, especially in the context of medical education.

Similar topics were touched in Finnish research about academic identity. User identity has a significant effect on how users experience a campus area and its buildings. Despite this, user identity does not necessarily meet the image of the organization. The strategic planning of spaces need to be done without forgetting the history and own identity of the users. (Airo and Rytkönen 2015). This finding has been published as a part of the large research and development program The Future learning environment 2011-2014 led by University properties of Finland. The learning environments of the future were investigated from the perspectives of campus co-operation, sustainable development, co-creation and multi-disciplinary learning. In the begin of the research program the expectation was to collect the new typologies for learning environments but at the end of the project it was found out that that equally important as the new solutions are the processes how they are realized together with users. E.g. the transition to sustainability is often seen as a top-down governing challenge, but it can include pioneering bottom-up ways to create change. Bottom-up actions in innovation should be given recognition and nurturing, as the bottom-up initiatives often challenge systems that resist change (Pulkkinen and Staffans 2005).

The existing premises of campuses possess a huge potential to be turned into lively urban centres that support learning and research of the future. Hence, the existing buildings can be seen as platforms for novel architectural solutions and stages for presenting the universities’ state-of-the-art education and research. Radical, extensive changes would most likely create the

biggest impact on behaviour and functionality. However, not all changes need to be massive and expensive. Like acupuncture, which releases energy by the point of a needle, so could the campus spatial structure be energized through small changes, which have a bigger impact than their size (Poutanen et al., 2015). According to Eriksson et al. (2015) retrofitting as technical and spatial solutions covers only part of the process. The activity-based retrofitting consists on multidisciplinary collaboration and learning processes where the diverse users have different roles during the retrofitting process. This will be discussed in the following chapter in terms of co-creation.

2.2 Need to Co-create in Campus Retrofitting Processes

Campuses are pioneers in facing the built environment challenges. The retrofitting processes are the additions of new technologies, features and functions to existing built environment systems. In university campuses this means the development of embedded learning environments, new space typologies, variety of platforms (both digital and physical) supporting collaboration within the university and in connection with diverse stakeholders. It means upgrading or replacing technical elements but also the changes in user activities and practices. Nevertheless it is connected also to service concepts and the new ways to produce services. (Eriksson et al., 2015) The purpose of user involvement in retrofitting processes means making fuller use of user knowledge and experience. Action and use of facilities is strongly related to experiences of the users and thus their possibility and will to perform. People create their own places in the facilities – they are socially constructed. Both technical and psychosocial systems are important when retrofitting campus. Co-creation allows and encourages a more active involvement from the users of the campus to create a value rich experience. Interpretation and analysis of the built environment and support services based on how it is socially constructed will enable integration of organisational use and the facilities provided to arrive at an understanding of usability of built environment (Alexander et al., 2013). The question is how retrofitting processes are conducted.

Sanders (2008) has been investigating the history of co-creation and stated that in Norway, Sweden and Denmark the Collective Resource Approach was established to increase the value of industrial production by engaging workers in the development of new systems for the workplace. The approach put together the expertise of the systems designers/researchers and the situated expertise of the people whose work was to be impacted by the change. The approach, thus, built on the workers' own experiences and provided them with the resources to be able to act in their current situation. In the broadest meaning of user participation it could be called "collective design" which was launched in early 1990´s. Collective design is something more than contributory influence and just participation. It is a process where knowledge and values confront, complete and modify each other leading to something new. All actors in the process are regarded as experts and their participation is therefore based on their relevant knowledge rather than on their roles as representatives for different interests. (Granath et al., 1996) Over the past ten years, together with increasing attention to the importance of front-end activities in general (Ryd, 2008; Blyth and Worthington, 2010), new interest in user involvement is emerging; though a change in focus is noticeable. The purpose of user involvement has shifted

from mere participation to co-designing, making fuller use of user knowledge and experience (Sanders and Stappers, 2008; Erikson et al., 2014).

CIB Work Group 111 on Usability of workplaces - with a significant amount of Nordic researchers and practical case studies - has been exploring concepts, methods and tools, developed in the usability of built environment, including also learning environments. A key product of the Nordic research project REBUS (User- oriented Benchmarking for Usability in Real Estate) was a process description, detailing how building owners and facilities managers can gather user experience from existing buildings as a basis for improving them, as input when designing new buildings, or as a reference when choosing new premises. (Lindahl et al. 2011). The universities comprising of the students, researchers, professors, lectures and other staff are the users of the universities properties. The university occupiers' needs vary from other commercial properties (e.g., offices) with needs regarding, i.e., lecture halls, laboratories and other special space. The university properties are often relatively large, made for a special purpose and can be difficult to convert to other usage. (Alexander et al. 2013)

To sum up it seems to be crucial to understand more the characteristics of co-creation methods in campus retrofitting processes in order to find out the ways for constant, future-orientated way to develop learning environments. Leaning on Nordic tradition on user-involvement we make the following analysis of campus-retrofitting cases.

3. Nordic studies about Campus Retrofitting

Campus Retrofitting (CARE) -project focused on innovative retrofitting of Nordic University Campuses. The goal was to develop and demonstrate scalable retrofitting, CARE-concepts for sustainable built environment management. The emphasis was in developing the systematic and continuous Campus retrofitting methodology, which is a system of broad principles or rules, from which specific methods or procedures may be derived to solve campus retrofitting problems in the context of developing future learning environments.

In Sweden, Denmark and Finland the Campus retrofitting studies were connected to developing new concepts for learning environment especially by understanding the diverse needs for informal learning. In Norwegian studies as well as in some Finnish studies the emphasis was in evaluation of the retrofitting concepts. In Norway especially in terms of the use of energy efficient solutions and in Finland in terms of the usage rates, indoor environment quality and user satisfaction of the solution.

The Danish study aimed to develop future learning environment together with users. The method used in Danish study was participatory workshops in DTU (Danish University of Technology) Campus Service – building client function for developing future learning environments. Instead of the usual approach: study tours they wished to get inspiration from "learning researchers". They conducted an action research process in spring 2015 with four workshops and participants were campus service representatives, teachers, students and users of Learning lab. The themes for the workshops were: Dream learning environment; What do we

know about learning spaces and what are the new typologies; Relations between learning space, technologies and learning and Performing University Spaces. The outcome was a new and different dialogue, which was engaging, strategic, open. It opened the bigger picture for participants and created the idea of a ”longitudinal community” to supplement existing organisational structures. The facilitators and experts of the workshops represented e.g. anthropology and business sciences. The approach was multidisciplinary by its nature.

The Swedish study aimed to build meeting places within the university designed to create and implement social responsibility and sustainability framework of Chalmers Real Estate Ltd. The method used in this study was based on best practice mapping by using the approach of human geography and urban sociology. They developed a manual for the meeting place builders called “Building Meeting Places - an introduction to strategic inter structure supply”. In parallel with the manual also a digital tool for inventory and analysis of the meeting places have been developed. Additionally the training of staff was part of the project. An inventory of meeting points on the Chalmers campus has been made during the spring of 2014, which formed the basis for future development with the physical environments. The manual includes a reviews of the meetings and venues evolved historically, trends that are relevant to today's and tomorrow's meeting place realization, models and theories to analyze and describe the meeting places' anatomy and character, as well as a number of concrete strategies and tools to develop and strengthen the different types of meeting places. The first demonstrations were made during the Campus Retrofitting process.

The Finnish study included 26 demonstration projects on different campuses of Finland, conducted by University Properties of Finland. Co-creation, realization, co-inesting and finally evaluation of activity based, multifunctional learning, research, and working environments were typical for the demonstrations. The retrofitting in case Musica, a building at Jyväskylä University Campus dedicated for education and research of music, aimed to plan a living room and learning/research spaces for the students by using Charrette-method. During the five day Charrette-process the new end-user goals were recognized and linked with the strategic principles of the facility department of the university, and the needed planning documents were created. Small scale campus retrofitting demonstrations concerning future learning and working environments in universities was the effective way to test new, unknown solutions and concepts. The costs were shared between user and property owner. (Naaranoja et al 2015)

In Tampere University of Technology, Finland students were in active role when redesigning under-used lobbies into a lively social and informal learning space. The halls and corridors, which are located in popular areas on campuses, have great potential as redesigned into novel social and informal learning spaces. Learning spaces located in circulation spaces reach students from all faculties, which also intensifies the use of the spaces as those compose typically up to 22% of the total floor area of Finnish university buildings. Campus-wide Wi-Fi and the culture of Bring Your Own Device (BYOD) enable all secondary spaces for informal and social activities. The three cases were novel learning spaces created in a lobby, a renovation of a campus café, and co-created learning spaces in an academic library. All of these demonstrations were successful in both attracting people and increasing the popularity of the space. Also the

indoor environment measurements provided evidence of sufficient comfort factors. Economically the demonstrations were inexpensive due to the fact that they were made by innovative student projects. Traditionally the renovation budget is used to return the facilities to the same level than they used to be – campus retrofitting demonstrations focus on developing the facilities for responding to the needs of future. (Poutanen 2015).

The Norwegian study focused on energy-efficiency improving methods for non-residential buildings and linked master student education with an on-going research project on energy efficiency improvement of non-residential buildings. They mapped the implementation in Norway by developing and conducting a MINDER survey with focus on existing methodologies. They learning environment was extended to visit and study energy-efficient buildings in its real life context. The students were invited to visit the buildings, analyse building documents, conduct interviews with practitioners and meet in the university classroom to present and discuss their findings. Best practice examples represented the most relevant building types and user organisations towards energy-efficiency improvement and were selected from the local municipality's energy-efficiency award. The students developed and presented findings with focus on innovative solutions for energy-efficient buildings' management. The aim was to analyse and improve the methods for innovative approaches for energy-efficient operation of energy efficient buildings. The survey cooperation with practice contributed to getting information and develops a deeper understanding about user-behaviour in energy-efficient maintaining of buildings next to technical facts and figures.

Additionally a Living lab case study have been followed up. The case was a single-family house at NTNU Gløshaugen campus in Norway with a gross volume of approximately 500 m^3 and a heated floor area of approximately 100 m^2. The house consisted of traditional residential spaces such as living room, kitchen and two bedrooms and it was used as a living lab. The ecological drivers for activities were low energy demand, passive and active use of natural resources and independency from the energy grid and lowering the environmental impact of the second home sector. Living Lab was developed in cooperation with industrial partners inside the Research Centre on Zero Emission Buildings (ZEB). The design included a wide range of components that can be adjusted according to users' needs and desires, functional program distribution and climatic context (envelope, furnishing, and technical system). The users interacted with buildings characterized by high indoor comfort conditions and low energy demand. The monitoring system of the use of the building has been designed in order to be flexible, expandable and easily reconfigurable. In addition sensors have been integrated in the building as it would be in a real house and chosen among those that can be installed in a real-world application - i.e. on- purpose-made sensors have been avoided as much as possible. The Living lab involved students, researchers and industry partners to develop sustainable solution and behaviour. (Finocchiaroa et al. 2014)

The analysis of the methods used in different Nordic studies was made by comparing the following aspects: How the users were involved to the studies and demonstrations, how the campus retrofitting process/project was realized in practice and economically and how the demonstrations were evaluated. The summary of analysis is presented in Table 1.

Table 1: Summary of campus retrofitting methods

Country / *Analysis focus*	*Denmark*	*Sweden*	*Finland*	*Norway*
User involvement	*Active role in workshops – source of ideas and information*	*Staff trained to meeting place manual*	*Active role in workshops – source of ideas and information*	*User behaviour in testing focus*
Realization	*Longitudinal community for on-going development was established for creating the future learning environments*	*Inventory of meeting points in campus and development of meeting place strategy for campus*	*Future learning environment demonstrations with co-funded budgets of owner and user. Partly realized as student projects*	*Producing and testing energy efficient solution with focus on user interface*
Evaluation	*Not yet*	*Not yet*	*Sensors for indoor environment, interval cameras, observations, user feedback surveys*	*Testing user-interface in Living lab Case studies on using and maintaining the energy efficiency of buildings*
Other remarks	*Trans disciplinary approach*	*Trans disciplinary approach*	*Diverse participatory methods*	*Integrating master student education and research*

4. Results

Based on the analysis the campus retrofitting methodology includes the following elements:

1. Active user participation and co-creation process: Campus retrofitting methodology indicates the importance to understand users and their needs as well as diverse activities, which set requirements for the future learning environments. The user was in all cases the main informant and also co-creator. The users were challenged to provide insights about their activities now and in the future. They were set to the active role also in designing the solutions. This activity based understanding is the basis of co-created and co-designed solutions.

2. **Commitment to share economical costs among stakeholders - co-financing:** The active stakeholders in Danish, Swedish, Norwegian and Finnish studies were the property owners or facility managers. They need to provide good university facilities and at the same time take care of the economical issues in order to achieve sustainability, sufficient usage rate of university facilities and efficient use of spaces. The economical structure was based on co-financing the projects by the university and by the property owners. The engagement of user and owner create cost-efficient ways to retrofit campus facilities.

3. Follow-up measurements - co-evaluation: Evaluation together with users and owners as by using diverse methods (e.g. user surveys, using sensors, interval camera and user feedback, user interface testing) to ensure the success of demonstrations was important in all cases. Co-evaluation provides evidence about effectiveness of the solution and material for learning and developing. It provides a longitudinal perspective for retrofitting processes and solutions.

The qualitative methods in connection with more traditional quantitative and objective methods together provided the valid process for proof of evidence in Campus Retrofitting (CARE)-demonstrations. The Norwegian study included survey, where the intention was to combine the technical data with the user data and enlarge the scope of fully technical approach to energy efficiency. In the Living lab case the user interface was the in user-test and both technical and user-data was gathered. The Finnish studies connected to campus lobby demonstrations included the measurements of usage rate and user satisfaction provided also quantitative data. In Danish, Swedish and other Finnish cases the methods were more qualitative by their nature including e.g. participatory workshops.

It was notable that the besides the different stakeholders the use of multidisciplinary approach was typical for the cases. E.g. Finnish charrette-process is based on method used traditionally in urban design. In the Swedish study the manual was based on human geography and urban sociology approach. In the Danish study anthropology and business sciences, e.g. management were part of the content of the workshops. The synergy between different disciplines and different actors provide material for new solutions.

5. Discussion

CARE-methodology has three key activities: co-creating, co-financing and co-evaluating. CARE-methodology can be framed and illustrated with the following Figure 1.

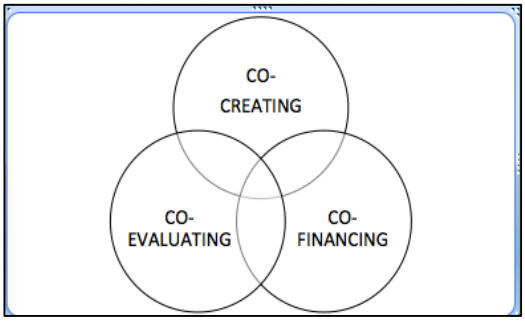

Figure 1: CARE-methodology

CARE-methodology consists on sharing: the vision, costs and results of retrofitting are shared between users and owners of campus in order to develop the future-orientated and sustainable agenda. The iterative processes of campus retrofitting differ from traditional linear technical projects. The activity based campus retrofitting is the on-going process and not limited to the certain phase of the retrofitting as a financial or technical process.

The Nordic studies provided material of planning itself but also new ways to provide continuity for the development of learning environments: it is important to provide proof of concepts and to engage different stakeholders. In order to use the CARE-methodology in practice the following steps are recommended: 1. Set the vision for the retrofitting process. 2. Identify the diverse actors for sharing the vision. 3. Define the budget among diverse actors and agree about the shared economy 4. Involve users to co-creation by using different methods. 5. Update user needs continuously, not only in the one dedicated, often predefined phase like e.g. specification of needs. 6. Decide and realize the user-centric evidence collection of the process and the solution. 7. Learn and develop continuously: there is not such a thing as "finished solution".

CARE-methodology can be a tool to capture new logic to learning environment design. The Nordic studies were chosen because they represent new and actual on going, experimental co-creating strategies at the universities, and we expected to gain new insights from these innovative processes, where the universities deviated from their standard practice. This has led to identification of new methods and contributions to the current literature on retrofitting of universities and learning environments. The two-year long project did however not allow longitudinal studies beyond one year or further co-creation processes. And this we recommend for future studies.

6. Conclusions

Nordic universities have been investigating campus retrofitting case-studies, which include a wide spectrum of methods how interaction and co-creation between students, teachers, researchers, real estate and FM staff as well as industry can take place in campus retrofitting processes. The wide user group represents a broad cross section of perspectives and experiences and provides a platform for fruitful discussions of the studied demonstration projects. The applied methodologies and the formulation of the guiding principle of the CARE way of sustainable retrofitting of university campuses could be applicable in the larger context of urban retrofitting. The methodology is not depending on learning environment or university campus context as such but it seems to be more transferable by its nature. It opens up an agenda for investigating a new methodology for sustainable urban retrofitting in a Nordic context.

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